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ABSTRACT

This paper examines the use of video-based contexts in a mathematics methods course for preservice elementary teachers. The effect of using video examples and analyses in methods courses and associated practicums on preservice teachers' field performance, preservice teachers' pedagogical content knowledge, and preservice teachers' decisions about mathematics content and teaching strategies were investigated. Included are characteristics of the subjects, procedures, discussion, and conclusions. Appended are a description of uses of video materials in mathematics education and a list of video materials. (KR)

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BRIDGING THE GAP BETWEEN THEORY AND PRACTICE IN THE TEACHING OF ELEMENTARY SCHOOL MATHEMATICS

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Purpose

Classroom-based educational research is generating new knowledge about effective teaching and learning of mathematics, while the field of cognitive psychology is providing important insights into how children construct meaning in mathematics. Additionally, educational reform recommendations are insisting that schools develop a higher level of mathematical and problem-solving ability in the nation's young people who will be tomorrow's workers and leaders. The role of the teacher in translating this information and these recommendations into educational practice is critical, and this presentation will examine the use of video-based contexts in a mathematics methods course for preservice elementary teachers.

During the Summer of 1988 as part of a National Science Foundation-funded project, the mathematics methods course for elementary teachers at Vanderbilt University was revised to incorporate a variety of short video illustrations into class lectures and activities. Prior to this time the course made only limited use of videotapes (two videotaped elementary school mathematics lessons were shown during one methods class session). Earlier versions of the revised course used edited videotapes, but during recent semesters the video illustrations have been provided using videodiscs controlled by HyperCard programs. The Appendix contains a description of these materials and their use in the course. The evaluation of that project has addressed the following questions:

1. How does the use of video examples and analyses in the methods course and associated practicum affect preservice teachers' performance in field placements?

2. How does the use of video examples incorporated into methods course lectures and activities affect preservice teachers' pedagogical content knowledge?

3. How do the various experiences in the teacher preparation program influence the preservice teachers' decisions about mathematics content and teaching strategies?

Subjects

Subjects were Vanderbilt elementary education majors (undergraduate and postbaccalaureate) enrolled in the mathematics methods course for elementary teachers and the associated field placement. Data were collected and analyzed for students enrolling over a period of three semesters: Spring 1988, Fall 1988, and Spring 1989. Those who were enrolled in this course before implementation of video during Spring 1988 provided baseline data. Data have been gathered on students enrolled in subsequent semesters. The project continues through Spring 1990.

Procedures

In order to determine whether the use of video illustrations has an effect upon the way preservice teachers teach mathematics, students in the methods course were observed during their field placement using an observation instrument developed for the project. Trained observers rated the preservice teachers' mathematics lessons in a variety of areas, including:

I Development of conceptual understanding
II Development of symbolic notation
III Development of basic skills
IV Development of higher-order cognitive and problem solving skills
V Instructional practices related to content
VI Instructional practices related to management
VII Provision for individual differences
VIII Development of positive attitudes toward mathematics.

Student behaviors observed include the following:

I Student involvement in the lesson
II Student understanding and interest
III On-task student behavior.

Other means of evaluation include structured post-observation interviews, an attitude survey, and a case study conducted by a doctoral student.

Discussion

Significant differences in teaching performance occurred in the following categories (See Table 1):

1. Development of basic skills

   The Fall 1988 and Spring 1989 practicum student group performed significantly better (.05 level of probability) than Spring 1988 practicum students ($F = 5.516$, $p = .027$).

2. Development of higher-order cognitive and problem solving skills

   The F-ratio, 5.924, obtained in the analysis of variance was significant at the .05 level ($p = .022$). Criterion scores for the Fall 1988 and Spring 1989 group of practicum students were significantly higher (.05 level) than scores of Spring 1988 practicum students.

3. Instructional practices--management

   The analysis of variance ($F = 4.524$, $p = .043$) indicated Fall 1988 and Spring 1989 practicum students performed significantly better (.05 level) than Spring 1988 practicum students in this category. The homogeneity-of-variance assumption underlying the analysis of variance was not met, however.

4. Development of positive attitudes toward mathematics

   The Fall 1988 and Spring 1989 group performed significantly better (.01 level) than the Spring 1988 group ($F = 11.143$, $p = .003$).

5. Student involvement in lesson

   The F-test ($F = 14.432$, $p = .001$) indicated Fall 1988 and Spring 1989 practicum students significantly outperformed (.01 level) Spring 1988 practicum students. Cochran's test indicated that the homogeneity-of-variance assumption was not met, however.

6. Student on-task behavior

   The Fall 1988 and Spring 1989 group performed significantly better (.01 level) than the Spring 1988 group ($F = 9.164$, $p = .006$).

No significant differences were indicated in these categories: (a) development of conceptual understanding ($F = 2.637$, $p = .116$), (b) development of symbolic notation ($F = .809$, $p = .377$), (c) instructional practices--content ($F = .685$, $p = .415$), (d) provision for individual differences ($F = .332$, $p = .511$), and (e) student understanding/interest ($F = .725$, $p = .402$). Because the numbers of students available for observation were small (10 lessons were observed for the baseline group and 18 lessons for the treatment group), these results should be viewed as preliminary. Data collection and analysis are continuing.

A second component of the evaluation sought to determine if students recalled information better if the information were presented with video illustrations as opposed to a traditional lecture/text format. The evaluation plan for this question is shown in Table 2. Table 3 contains a summary of the results of these analyses. Video and non-video groups performed equally well on traditional course examination items (Barron et al., 1989).

Observational and interview data were collected in a naturalistic inquiry case study during the Fall of 1989 (Berk, 1989) of the effects of the technology on Vanderbilt teacher education students. When students were asked about their reactions to the technology, they gave the following types of responses: (a) students found the video illustrations and analyses valuable, (b) they felt more confident in presenting mathematics

lessons after having seen and analyzed the video illustrations, (c) they thought HyperCard was an effective instructional tool, and (d) they felt more involved in the instruction when they had access to the information through the computer than when class was conducted in a more traditional lecture format. Students cited as especially beneficial the illustrations of children's misconceptions, examples of lessons and activities, and consideration of different options for presenting mathematical concepts.

Conclusions

We have concluded that the use of video examples makes a difference in both the teaching performance and the self-confidence of preservice teachers, and that the hypermedia platform is an effective and efficient way of organizing the video illustrations and integrating them into the course content.

Table 1

Means and Standard Deviations for Observation Scores for Practicum Students--Spring 1988 Semester and Combined
Fall 1988 and Spring 1989 Semesters

	Semester					
	Baseline			Video		
Variable	Mean	Standard Deviation	n	Mean	Standard Deviation	n
Comp. I	13.19	1.24	10	14.40	2.36	18
Comp. II	7.25	1.13	10	7.60	.91	18
Comp. III	5.42	.66	10	6.19	.91	18
Comp. IV	5.20	1.54	10	6.39	1.04	18
Comp.V	20.42	1.89	10	21.34	3.20	18
Comp. VI	8.40	.97	10	10.11	2.42	18
Comp. VII	8.92	.96	10	9.29	1.63	18
Comp. VIII	8.20	.63	10	9.00	.59	18
St. Beh. I	3.10	.88	10	3.98	.35	18
St. Beh.II	6.60	.97	10	6.94	1.06	18
On-task Beh.	78.20	8.74	10	86.63	5.98	18

Note. Maximum possible scores for the categories were Competency I: 20, Competency II: 10, Competency III: 10, Competency IV: 10, Competency V: 30, Competency VI: 15, Competency VII: 15, Competency VIII: 10, Student Behavior I: 5, Student Behavior II: 10. The On-task behavior mean was a percent.

Table 2

Evaluation Plan

I = Fall Semester Methods Class 1988
II = Spring Semester Methods Class 1989

Course was subdivided into four modules, referred to as Module 1, 2, 3, 4.
Treatment levels were Video presentation, Non-Video presentation.
Experimental Design was Balanced Blocks, blocked on Modules and on Semesters.
The criterion was scores on "traditional" test items over material of each module.

Design layout is

	Video	Non-Video
Module 1	I	II
Module 2	II	I
Module 3	I	II
Module 4	II	I

The design can also be viewed from the layout

	I	II
Module 1	Video	Non-Video
Module 2	Non-Video	Video
Module 3	Video	Non-Video
Module 4	Non-Video	Video

which demonstrates the blocking with regard to semesters.

Table 3

Means and Standard Deviations for Fall 1988 and Spring 1989 Methods Students' Scores on Experimental Module Questions

Module Topic	Treatment			
	Video		Non-Video	
	$\bar{x}$	s	$\bar{x}$	s
Readiness	27.32	4.23	28.83	6.34
Subtraction	24.02	10.00	28.59	8.49
Fractions	26.50	4.48	27.35	5.98
Geometry	30.80	4.94	31.14	2.82

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Appendix

DESCRIPTION OF USES OF VIDEO MATERIALS IN MATHEMATICS EDUCATION

Five pilot, or prototype, videodiscs are being tested. Each disc is organized around some theme (e.g., expert-novice contrasts in mathematics teaching) or content topic (such as teaching fractions or teaching subtraction), but there is enough information on each disc to allow it to be used with a variety of topics normally covered in the course. For example, the "expert/novice" disc is built around two lessons on linear measurement, each of which had the students rotate to different stations to measure objects. When using this disc, a course instructor might focus on (a) organization and management issues related to a hands-on activity, (b) development of decimal notation, (c)integrating science and mathematics (the lesson was actually a science lesson), (d) teaching measurement, or (e) contrasts between beginning and experienced teachers (a beginning and an experienced teacher taught the same lesson). The random-access capability of the videodisc allows video segments to be retrieved almost instantly for analysis, illustration, or contrast.

The videodiscs are controlled by specially-designed computer programs using HyperCard, an authoring system available for Apple Macintosh personal computers. HyperCard allows information to be accessed instantly through a variety of media, including text, sound, graphics, video, and computer animation (thus, the term "hypermedia"), and the HyperCard control permits the video to be organized into "stacks," or collections of "cards," each containing information in a variety of forms (e.g., text, pictures, or tables). The cards also contain fields or audio or video "buttons," on which the viewer can "click" the mouse to interact with the computer. The HyperCard control permits the viewer to choose a topic (such as one of those described in the previous paragraph) or perspective from which the lessons and examples on the videodisc may be studied.

The prototype videodisc/HyperCard materials are being used in methods classes at Vanderbilt to provide structured experiences in analyzing various aspects of elementary-level mathematics lessons. The instructor may use part of a HyperCard stack and related videodisc segments to illustrate points in a lecture or to lead discussion of issues such as a child's interpretation of a geometry task, a teacher's response to a child's misconception, or a teacher's choice of representation or materials. Though the materials work quite well in a "presentation format", we now schedule the course in the computer lab to allow the students individual access to the HyperCard stacks. The students work at computers in pairs or individually during the discussion, and the HyperCard texts and menus substitute for more traditional lecture notes. In this manner, students working in small discussion groups are given case-based practice in interpreting and constructing models of children's performances in content areas such as fractions or subtraction. Roughly one third of the class sessions are conducted in the computer lab, and the stacks are available to students during lab hours for additional study.

EXAMPLES OF VIDEO MATERIALS

MULTIPLE PERSPECTIVES: The first videodisc produced through the NSF mathematics project (TPE # 8751472) was designed to examine a mathematics lesson from a variety of perspectives--those of a mathematician, a mathematics educator, a cognitive psychologist, a sociolinguist, an expert in classroom management, and the teacher herself. We have used the disc in a "presentation format" with the presenter controlling the choice of segments and comments. When this is used with a class, we show the entire segment of the lesson (approximately 8 minutes in the edited format we are using on the disc) and then select incidents from the segment and related comments from the specialists. The purpose is to show preservice teachers how the various courses they are taking serve as a foundation for the complex act of teaching, and the disc is clearly more useful than a linear tape for this. A major disadvantage of the disc format is the thirty-minute limitation on video and the fact that the specialists' comments take up much of the video space. In the future we will use HyperCard text or audio to replace the filmed comments of the specialists.

MULTIPLE USES: The second disc produced used edited versions of two subtraction lessons taught by a practicum student and her cooperating teacher in a first grade class. The extra space on the disc was filled with short videotaped segments designed to allow as many uses as possible for the disc; most of these

segments had been used in the methods class at least once in the videotape version to illustrate some aspect of teaching or learning mathematics. The possible topics for which the disc can be used include:

Interpretations: The four interpretations of subtraction covered in the methods course text are illustrated in the lessons or in added segments.

Constructing meaning: The children are encountering subtraction concepts for the first time. Several interesting misconceptions arise during the course of instruction--ones which novice teachers are not likely to notice.

Representations: The teachers are using a variety of representations with the children. The disc can provide examples of the different representations through which children construct meaning in mathematics.

Self-analysis of teaching: The practicum student used this lesson for the self-analysis of a lesson (required in the practicum associated with the methods class). Her videotaped comments on the lesson are included in the disc, and the disc can be used to illustrate the self-analysis assignment.

HyperCard stacks have been developed to lead the viewer through the different topics. Although this disc can be used in a presentation mode also, a major goal of the HyperCard link is to provide for independent, guided viewing. The ability to pull out citations from the literature and to illustrate with classroom examples is particularly useful as we seek to incorporate research into the teacher education program. We are looking at the possibility that a series of such discs can be located in a "hypermedia laboratory."

EXPERT/NOVICE CONTRASTS: The third NSF disc contains edited versions of a science lesson on measurement taught by a practicum student and the same lesson taught by her cooperating teacher (a member of the NSF consultant teacher staff). The disc format allows the viewer to focus on contrasts between expert and novice teachers and illustrates a number of points found in the expert/novice literature on teaching. We used this material in one of the pre-practicum classes, and feedback from teacher education students has been particularly interesting. Students report that seeing one of their peers teach a lesson in a practicum assignment similar to the one they are about to begin is very comforting. They find the discussion of common problems of novice teachers reassuring, and they realize that we do not expect them to perform as experts. We also used this disc for a "research interpretation" session at the 1989 annual meeting of NCTM and the feedback from that session was very positive. We demonstrated how HyperCard stacks can be used to relate the video examples to the literature. We are refining the HyperCard stack associated with this disc.

TEACHING FRACTION CONTRASTS: This disc illustrates teaching contrasts. Some of the video examples of children's difficulties with fractions were used in one of the "evaluation modules" in the NSF project. The disc was designed to show effective and ineffective instruction and the way children respond to that. This is the first (reasonably) successful effort to "stage" examples of poor teaching. On the surface, this staged lesson does not appear to be terrible because the teacher is well-prepared and classroom management is not a problem. However, upon looking more deeply into the lesson, one sees, for example, that students are obviously confused by the symbolic representations which precede the concrete and pictorial ones. Hence, practicum students are trained to look at pedagogy more critically.

This disc is, also, our first effort to explore what "hypermedia publishing" might look like--the disc is based upon Mary Lou Witherspoon's thesis.

MANIPULATIVE MATERIALS/READINESS: The latest disc focuses on the use of manipulative materials in elementary school mathematics and on various aspects of readiness. Practicum students realize that they are supposed to use concrete materials to develop concepts, but knowing how to do so is a complex matter. One purpose of this disc is to show effective, as well as ineffective, uses of manipulatives so that preservice teachers can choose activities and materials that will help students to construct meaning. In addition, there are several illustrations of teachers addressing such issues as pedagogical readiness, maturational readiness (using Piagetian tasks), and content readiness.

This disc and its accompanying HyperCard stack were also used for a presentation for the 1990 southeast regional meeting of NCTM. Reaction was quite positive.